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THE EYE AS A FACTOR IN THE CAUSATION OF SOME COMMON NERVOUS SYMPTOMS,

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Although something has been written within the past few years in relation to the deleterious effects of errors of refraction and accommodation of vision and the condition known as "muscular insufficiency" upon the functions of the nervous system and the viscera,† the profession at large is not yet thoroughly awakened to the importance of the detection and correction of such errors.

Most of you know that some persons can be made dizzy by looking from a height or inspecting a water-fall; you have doubtless seen laymen suffer pains in the head and be made "sick at the stomach" by trying on a pair of spectacles

* An abstract of two lectures delivered before the students of the New York Post-Graduate Medical School and Hospital.

† Priority in this field (save in respect to ocular defect as a cause of headache, which has been recognized in a somewhat imperfect way for

which gave relief to a friend.* You doubtless know that a "squint" in the eyes is very often due to some defect in the refraction of the eye or a weakness of its muscles; but possibly some of you do not know that a squint will occasionally disappear at once when the proper glasses are given to such a patient, without recourse to cutting the muscle. Perhaps it has never occurred to most of you that sight is the *only special sense which we use constantly* except during the hours of sleep. There is not a moment of the day or evening when we are not acquiring visual impressions of some kind.

Fortunately for our nervous system, the normal eye takes pictures of surrounding objects *without any muscular effort* when the object is more than twenty feet away; hence, during the larger part of each day, the *normal eye is passive*, and is practically at rest, although performing its functions. How different is the condition of the far-sighted or "hyper-

many years) is justly claimed, as far as I know, by Dr. George T. Stevens of this city. Although his views have been regarded by some as extreme and untenable, those who have carefully and accurately investigated the eyes of nervous subjects can not, I think, deny that defects in refraction and accommodation, and insufficiency of the ocular muscles, are very important and generally neglected factors of causation. Authors can not afford to-day to utterly discard all mention of the tests for muscular insufficiency from neurological works, as they have done in the past. In point of fact, even the tests for errors in refraction are not described in the standard works on nervous maladies. Most authors seem to have been content with showing a cut of some ophthalmoscope and dismissing the subject with a few lines. It is safe to infer that such writers are either not familiar with the field here discussed, or not in the habit of employing the tests herein described upon their patients. I am sure (if this is not the case) they could not remain so apathetic and apparently indifferent to the results obtained.

* Let a healthy child try on its grandfather's spectacles and wear them for a time, and the effects of "*eye-strain*" will be very clearly exhibited *by distressing symptoms in a few minutes.*

opic" eye, however, from the normal! For this eye (since it is *too short* in its antero-posterior axis) all objects *have to*

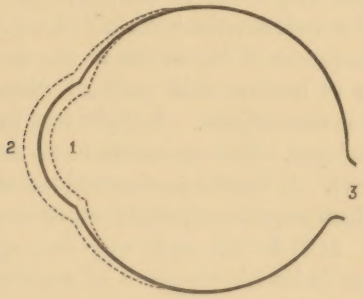

FIG. 1,—DIAGRAM TO ILLUSTRATE CONGENITAL OR ACQUIRED DEFECTS IN THE ANTERO-POSTERIOR DIAMETER OF THE EYE.—The *black line* represents the *normal line* of the eye. No. 1 represents the *hyperopic* eye; 2, the *myopic* eye; 3, the optic nerve.

be focused by muscular effort, irrespective of their distance from the eye. Such an eye is never passive. It has no rest while the body is awake. It is always straining more or less intensely to bring properly upon the retina the images of objects seen.

THE FLATTENED EYE.—The "hyperopic" condition of the eye, or "far-sightedness," as it is called, is a very common defect. It is especially frequent in persons of tubercular parentage.* It is well, therefore, to suspect the existence of this defect in children or adults whose ancestors have died of "consumption."

Hyperopia can not be corrected too early in life. It is unquestionably one of the *most frequent causes of "sick-headache,"* which, as you know, runs in families. It is commonly encountered also (among other optical defects) in subjects afflicted with chorea and epilepsy.† It is a con-

* This is probably due to the shallowness of the orbits.

† Dr. George T. Stevens was the first, so far as I know, to advance

genital defect, and will never be "outgrown," as many people think. A hyperopic child, from the days of babyhood, suffers (unconscious perhaps of the fact) from a variety of symptoms which indicate the "strain" to which it is subjected in consequence of its efforts to see distinctly. Its eyes are liable to become easily suffused when it plays or looks steadily at near objects. A slight cast in the eye is sometimes developed. It occasionally "sees double" after it learns to read. It usually prefers and excels in out-of-door sports, which require only slight efforts at accommodation of vision. It finds that study and close application to books bring an indescribable sense of weariness and discomfort; hence, study becomes irksome and play brings a sense of peculiar relief. Some years ago Dr. Loring, of this city, wrote an article for "Harper's Monthly" which treated of hyperopia and myopia in a charmingly lucid and popular manner.

Now, one peculiar fact should be noticed here—viz., that *hyperopic subjects often have remarkable acuteness of sight.* They are very apt (when young adults) to boast of their power of vision. They can often read all the test-types made for distance (twenty feet or more) without an error. If the defect exists in a child, the parents will frequently tell

the general proposition that ocular defect was an important factor in causing functional nervous diseases, that muscular insufficiency (chiefly of the externi) was particularly apt to cause such disturbances, and that they could be relieved by tenotomy. I have an epileptic child under my care at the present time whose attacks have averaged four a day for several years. *The fits will cease at once when the child is at sea*, possibly because efforts of accommodation are almost entirely dispensed with when on deck. Hyperopia, astigmatism, and external insufficiency exist in this patient. The use of atropine caused a complete cessation of the fits for several days. Why can not the eye act as a disturbing element as well as phimosis, sexual excesses, ovarian irritation, etc., concerning which so much has been written?

you how the child can see things with distinctness which possibly they themselves can not see at all; how they have tested its eyes from time to time; how absurd the idea seems to them and their friends that the vision of the child is defective; and how unnecessary the use of glasses seems to them (even if the eye is abnormal) so long as the child can get along without them. In some cases no amount of explanation or pleading will persuade the parents to have the ophthalmoscope or atropine used upon the child's eyes in order to decide the question of the existence of "latent" far-sightedness.

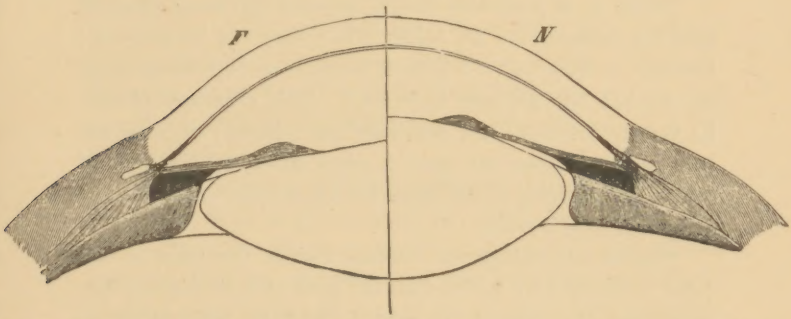

FIG. 2.—SECTION OF THE FRONT PART OF THE EYE, SHOWING THE MECHANISM OF ACCOMMODATION. (Fick.) The left side of the figure (*F*) shows the lens adapted to vision at distances of over twenty feet; the right side of the figure (*N*) shows the lens adapted to the vision of near objects, the ciliary muscle being contracted and the suspensory ligament of the lens consequently relaxed.

Some years ago I pleaded with a medical man to allow some oculist of reputation to examine his children's eyes, all of whom had weekly attacks of sick-headache, inherited from both the mother and father, and in whom a tubercular tendency was strongly marked. I was refused, and the statement was made that never, while the father lived, should a child of his wear glasses with his consent. One of these children wears to-day a convex glass with a twelve-

inch focus for distance; another wears the same glass with five degrees of prisms added. These only partially correct an insufficiency of the muscles which exists in addition to the hyperopia. A third child is highly hyperopic and astigmatic. In every one of these subjects immense relief has been afforded by the correction of an optical defect which had rendered their early life one of suffering. This is not an uncommon experience. I could cite many more, if I deemed it necessary to prove what is already accepted by ophthalmologists as proved—viz., that hyperopia and eye-defect of other forms may prove to be *fruitful sources of headache.*

There is a prejudice among laymen and some medical men that glasses are an injury when they can be avoided; because, as they say, "a person becomes so dependent upon them when he once puts them on." This argument should be exactly reversed, and construed as follows: *Because nature becomes dependent upon a glass which gives relief and corrects an existing strain upon the eye, no time should be lost in affording this relief.*

Should a hip-splint be avoided (when the pain in the joint is arrested by it) because the patient feels his dependence upon the splint? Should a child be allowed to go through life with a deformed eye simply because the defect is not apparent to himself or his friends on account of an unnaturally developed ciliary muscle (see Fig. 2), which for a time renders the eye capable of getting along tolerably well in spite of its deformity?

More harm is being done to-day to the community at large by this fallacious argument than it is possible to compute. Thousands of sufferers from sick-headache and neuralgia are to-day struggling along through life with an optical defect uncorrected, and, in many instances, after costly experimentation with drugs and doctors, are left in despair of cure.

I speak strongly upon this point because I believe that

the gastric symptoms which accompany typical attacks of sick-headache are not to be explained (as they commonly are) on the ground that the "liver is inactive," or that "dyspepsia exists," or that "the gastric juice is weak," or that "the patient uses tobacco to excess," or that "he has been living too high." Every one who has suffered for years with these attacks knows that they often occur without explainable cause; that they are cured sometimes by eating, drinking, and smoking, and made worse at other times by similar indulgences or excesses; that every known remedy is apt, sooner or later, to prove inoperative, and that a sure specific for them is unknown among the drugs of our Pharmacopœia. These subjects also know that life is rendered almost unendurable by the attacks at times. They are tractable patients, and will try anything, live in any way specified, and bear any privation without a murmur, if it will insure a cure.

I believe, from a personal experience of my own of this kind (which it is unnecessary to relate here), and from some experience also in examining the eyes of this class of sufferers, that the symptoms of sick-headache are reflex in character to a large extent, and are due primarily in almost every case to some optical defect. We can easily demonstrate that disturbed brain-action from "eye-strain" may produce in a healthy child and in some adults all of the symptoms of these attacks in a few minutes. Why is it irrational, therefore, to affirm that a brain (disturbed by the constant efforts made to use eyes which are abnormal in respect to the refraction, accommodation, or the equilibrium which should exist between its various muscles) may manifest its disturbed state by nausea, headache, vomiting, dizziness, constipation, and other evidences of imperfect performance of the functions of the viscera? Does not our central nervous system regulate and directly control those

functions? Is it not as probable that the master when upset disturbs the servants under him, as to advance the argument that the servants themselves are the all-important factors in causation?

The Elongated Eye.—When the eye is too long from before backward, the patient is said to be "myopic," or *near-sighted.* Distant objects are more or less indistinct to such an eye in proportion to the excessive length of the antero-posterior axis of the eye over the normal standard. No amount of muscular effort can overcome or improve this defect in vision; hence these individuals are not subjected to the muscular strain which far-sighted persons constantly and unconsciously exert in order to see at a distance. Again, the near-sighted eye can read or perform any of the functions required of it (when brought sufficiently close to the object) without any muscular effort of an unnatural character. In contrast, the far-sighted eye has to exert a still greater muscular effort to see near objects distinctly than when employed upon distant objects; hence the fatigue, the blurring of letters upon a printed page, the watering of the eyes, the pain in the eyes and head, and the many other ills previously described.

Near-sighted subjects are generally conscious of an eye-defect, because they can not see across a room with distinctness or recognize familiar faces on the street. They are apt to become very fond of occupations which bring the eye close to their work, because they have no difficulty in seeing the object. Near-sighted children are liable to be considered precocious beyond their years, because they prefer to read rather than to play out-of-doors. It is generally safe to conclude that a child is near-sighted when it avoids out-of-door amusements in order to gratify a taste for reading or in-door occupations.

Near-sightedness is less liable to induce nervous dis-

turbances than far-sightedness, provided it is not accompanied by astigmatism or muscular insufficiency. Yet it should be remembered that myopic subjects are more frequently sent to the oculist for relief than hyperopic subjects are, because the defect in vision is very apparent to all in the former class, and is more often unsuspected than recognized in the latter.

The Astigmatic Eye.—You may find, in the third place, when you have examined the eyes of patients or friends who suffer from headache, persistent neuralgic attacks, etc., that a condition of the eye known as "*astigmatism*" may be detected, co-existing with far- or near-sightedness, or independent of these refractive errors. In such subjects the cornea or the lens of the eye (see Fig. 2) has a *greater curvature in some meridians than in others;* hence the images of all objects seen are more or less distorted when they fall upon the retina. To this class of sufferers some letters in the tests employed will be distinct, while others will not. If a number of dots are made upon a blackboard or a sheet of paper, some will appear as ovals, with a hazy border, or as lines, while others will more closely resemble the normal appearance of the dots. Finally, if a card, with lines running from its center to its periphery (the "clock-face test"), is used, some of the lines will appear blacker than the rest and more clearly defined. Now, there can be no comfort to such subjects in their visual efforts. They learn by practice and experience to properly interpret, after a while, the imperfect images of objects seen, and they are aided in so doing by the fact that the outlines of letters, etc., become clearer in some positions, as regards the eyes, than in others; but, in spite of all that may be said to the contrary, the strain of using imperfect eyes tells upon most astigmatic persons sooner or later, and tends to excite reflex nervous phenomena of various kinds. To properly correct

astigmatism by glasses is often an extremely difficult matter. It requires experience, a thorough knowledge of optics, and a familiarity with the practical use of the ophthalmoscope. There are comparatively few physicians (outside of the specialists in ophthalmology) who are capable of managing a bad case of this kind with perfect success. You can, however, easily detect its existence in most cases. When you discover it, I would advise you to intrust its correction to skillful hands.

Certain abbreviations are employed by oculists to designate various forms of astigmatism which may be detected. These are of use in recording the results of an examination:

Ah stands for *simple hyperopic* astigmatism.

Am stands for *simple myopic* astigmatism.

H + *Ah* stands for *compound hyperopic* astigmatism.

M + *Am* stands for *compound myopic* astigmatism.

M + *Ah*, or *H* + *Am*, stands for *mixed astigmatism*.

THE ASTHENOPIC EYE.—Finally, it is very important that you determine (in each patient whose eyes are examined by you) the *condition of the muscles* of the eye. The term "asthenopia" is commonly applied to that condition of the visual apparatus which entails suffering in consequence of a defective "equilibrium"* in the muscular power exerted upon that organ when a fixed position of the eye is maintained for any length of time. When a state of perfect equilibrium is impaired from a weakness in some muscle of the eye, the effects become manifested sooner or later by pain and great discomfort after the eyes are used for any length of time. I have seen patients who could not attend a place of amusement, or read or sew, for even a

* A term brought into prominence by Dr. H. D. Noyes, of this city, in a paper read before the International Medical Congress at Copenhagen on Insufficiency of the External Recti Muscles.

short time, without great distress from this cause. These patients may or may not have a refractive error. In some instances, no glass but *prismatic ones* will benefit them.

A high-couraged horse feels the will, as well as the support, of his driver through the reins by means of the bit. Although his course and rate of speed are changed from time to time at the will of the driver, the reins are never slackened. The horse becomes acquainted with the desires of his master by a sense of increased or diminished tension upon the reins. He is guided to either side by a difference in the tension of the two, although the driver does not entirely relax his hold upon the opposing rein while he uses the guiding one, and the difference in tension may be very slight.

So it is with the normal eye. It is both controlled and supported while performing its movements within the orbit by the eye-muscles (which are its reins). The brain is the driver. At its command the eye revolves, or remains stationary at any desired point. The tension of muscles, opposed to any movement of the eye required, is so modified by the brain as to insure the requisite support to the eyeball, and to steady it as it moves. Thus a perfect equipoise is constantly established between opposing forces, adjusted with the nicest care to meet the full requirements of the organ under all possible circumstances. The normal eye does not tremble or wabble when it moves or the attempt is made to hold it in any fixed attitude. It is a piece of machinery, perfect in all its parts, reliable in its movements, perfectly controlled by its master.

The eye with "muscular insufficiency" is like a horse with an inexperienced and incompetent driver; the proper tension upon the reins is not maintained at all times, as it should be; there is no equilibrium between antagonistic muscles; fixed attitudes are maintained with difficulty for

any length of time: the brain becomes more or less disturbed by its inability to properly control the eye-movements, and exhausted by the continual strain imposed upon it by the efforts required to do so even imperfectly.

Asthenopic subjects are *very frequently encountered* in the practice of a neurologist. The oculist, perhaps, sees them still oftener, because they are generally conscious that something is wrong with their eyes. Still, there are exceptions to this rule. I have examined patients who showed, in response to appropriate tests, very high degrees of muscular "insufficiency," that came to me for the relief of symptoms which had never been referred by themselves or their physician to any possible eye-defect. I recall the case of an epileptic who was placed under my charge. His family assured me he had "wonderful eyes"; and they were surprised when I examined them with care. The results of this examination showed, however, that twenty-five degrees of external insufficiency existed (as measured by the vertical diplopia test), and that he was hyperopic and astigmatic to a marked degree.

Insufficiency of ocular muscles seems to me to be a *congenital defect* in most cases—possibly in all. It is encountered in very young subjects. It is not a paralysis or a true paresis. It seems to vary with the nervous condition of the patient. It is not uncommon to note wide variations in the same case, if examinations are made from time to time. Possibly this fact helps to explain why competent observers do not always estimate the degree of insufficiency in a given case alike, even when similar tests are employed and equal care is given to the case. *We have no way, as yet, of determining "latent" insufficiency*, as we do latent hyperopia by atropine. Should a patient show us an insufficiency counteracted by a prism of a certain angle today, it only proves that he has *at least* that amount, not

that he has no more. This statement can, I think, be demonstrated. It is an important fact to remember, when the results of examinations of such patients made by yourself are at variance with the observations made by another.

Without further preparatory remarks, I pass to the consideration of the steps commonly taken to determine if the eye (regarded purely as a piece of mechanism) is perfect or imperfect. The study of the eye, when any of its component parts *become the seat of disease*, has no bearing upon the subject under discussion. This field is properly relegated to oculists.

The Tests of Vision and Ocular Movements.

The steps which should be employed in examining the eye for errors in refraction and accommodation, as well as those employed to detect defect in the power of ocular muscles, have not thus far been discussed. I expect to offer nothing new, but I hope to make the details of such an examination simple and within the comprehension of all.

The importance of this department of diagnosis can hardly be overestimated in nervous maladies. It has been my custom for some time past to examine the vision of nearly every patient sent to me, as my experience has shown me many times that remarkable cures may be made by the light thus shed upon the causation of obscure nervous symptoms.

Unfortunately for the sick, in many instances, physicians in general seem to think that the examination of the eye is too difficult a field for them to intrude upon without some special preparation for it. While this is undoubtedly true, in case the ophthalmoscope is to be employed, it is by no means a difficult matter for a person acquainted with physics to acquire a practical and satisfactory knowledge of the few tests here described in a comparatively short time

and with but a limited number of patients, provided that he works faithfully and intelligently. The healthy (?) as well as the sick can often be used to familiarize the beginner with the practical adjustment of prismatic, spherical, and cylindrical glasses, and also with the tests employed to detect "asthenopia" or insufficiency of the eye-muscles.

Defective vision does not always produce ill-health; hence among your friends or in your immediate family you may find a field for investigation and practice.

Now, in the first place, it is not necessary to have a complete Nachet case of lenses. Such a case is very expensive. By selecting a limited assortment of lenses and prisms, different combinations can be made to meet the needs of almost every eye-defect encountered in medical practice.

Now, there is furnished, with the various small cases designed by prominent oculists, a sheet of Snellen's test-types for distance, and also one containing several paragraphs printed in an assortment of types of various sizes, to be used as a test for reading power. Each paragraph is numbered, so that a record can be kept of the one read by the patient as a test. These test-type slips can be purchased separately, however, of any optician. It is best to have each *mounted on card-board;* and it is well to have the one used in testing for distance a double one, with different letters on the opposed sides. If you suspect that the patient is *using his memory* during the tests employed rather than his sight, the board can then be exposed upon different sides at various periods of the examination.

You will find that the letters are mathematically made for testing distant vision. Above each line a numeral or Roman character is placed to designate the *number of feet at which the normal eye should read the line with ease.* Thus, the large letter on the top line will be designated

usually by 200, or C C, while small letters of the lower line will be marked 10, or X. This shows that the top letters should be read easily at two hundred feet by the normal eye, and the lower line at ten feet. After you have provided yourself with a good trial-case, a set of prisms, and the necessary test-type, let us see how you should proceed with an examination of a patient's vision. Let us illustrate the steps by using one of the class as a patient.

I first hang up on the wall, as you see, the test type for distance; and I place the patient with his eye on the same level and a distance from it of exactly twenty feet. I then take the triple-grooved spectacle-frame from the trial-case and insert a plate of metal in the left rim of the frame, so that when it is used by the patient the left eye will be covered. I then place this frame upon the patient and ask him to read aloud the letters on the testing sheet from the top downward, line by line. This act tests his vision in the right eye. I note (while he reads) the following facts: (1) If he *calls all the letters properly;* (2) if he *reads without apparent effort;* (3) at *what line he fails* to read. I then make a record as follows: O. D. (oculus dexter, or right eye) V. $= \frac{20 \text{ (feet)}}{\text{— (type)}}$. The dash in the fraction is filled with the number which indicates the last line which the patient reads. When the vision is normal, the fraction will be as follows: V. $= \frac{20}{20}$ or $\frac{20}{\text{xx}}$. If the patient fails at the line next above the normal point, the fraction would be expressed by $\frac{20}{30}$ or $\frac{20}{\text{xxx}}$. Remember that the *numerator* represents the distance (in feet) between the patient and the test-type, and that the *denominator* represents the numeral on the test-card placed above the last line of type read by the patient (which indicates the normal distance in

feet at which it should be legible to the normal eye). Now, if the vision of the right eye is found to be defective, try and improve it, and, if possible, to render it normal, or as nearly so as possible, by testing the effects of concave or convex glasses upon it as the case seems to indicate, beginning with the weakest lenses and gradually increasing their strength until the vision reaches its highest acuteness. This takes some little practice and experience. If *convex glasses* are found to be indicated, note the *strongest* which gives the best vision to the patient; if *concave*, record the *weakest* glass that overcomes the defect.

In some cases you may find yourself unable to obtain normal vision in either eye by means of cylindrical or spherical glasses. I presuppose a certain degree of acquired facility on your part with glasses of the forms specified, and a carefully made effort to overcome the existing defect.

In such a case it is well to consult some expert oculist (if near at hand), and thus to ascertain the results of an *ophthalmoscopic examination*. The patient may have some mechanical impediment to vision, such as an opaque lens within the eye (cataract), or an opacity of the cornea; or he may have a high degree of astigmatism, which can often be estimated with some accuracy by the ophthalmoscope. Again, he may be found to be suffering from morbid changes within the optic nerve or the retina.

When it is found that a patient is so blind in an eye as to be unable to recognize any of the letters on the testing-card at any distance, you should note (before sending him to an oculist) if he can recognize with accuracy the *number of fingers* which you hold before the eye, and record the results of such investigation. You should make this test with the fingers in all possible positions in reference to the diseased eye (directly in front, above, below, and to either side of it).

We might record the results of an examination of a supposititious case up to this point as follows:

$$\text{O.D. V.} = \frac{20}{\text{xxx}} \text{ (manifest) made } \frac{20}{\text{xx}} \text{ by } + 30 \text{ glass.}$$

The word "*manifest*" in this record means that the far-sightedness or "hyperopia," which *apparently* exists, is overcome by a convex or (+) glass which focuses at thirty inches. After the use of atropine, any increase over this amount which may be developed is recorded as "*latent*" far-sightedness. I use here the old style of numbering glasses for the sake of perspicuity, although I personally prefer the metric system (dioptre), as it allows of more rapid combinations when the trial-case contains only a limited supply of lenses.

You will understand, when I exhibit the method of recording such observations more fully to you, why it is that the right and left eyes have to be separately examined and corrected (as already described) before the binocular vision is tested with and without the needed correction. I usually make upon the page of my own case-book a note prior to the use of atropine somewhat as follows:

$$\text{O. D. (right eye) V.} = \frac{20}{\text{xxx}} \text{ (manifest) made } \frac{20}{\text{xx}} \text{ by } + 30.$$

$$\text{O. S. (left eye) V.} = \frac{20}{\text{xl}} \text{ made } \frac{20}{\text{xx}} \text{ by } - 30.$$

$$\text{Binocular V.} = \frac{20}{\text{xxx}} \text{ made } \frac{20}{\text{xx}} \text{ by } \textit{this combination.}$$

Such a record of a supposititious case would show that the patient was *far-sighted* or "*hyperopic*" in *the right eye*, and *near-sighted* or "*myopic*" in *the left eye*. It would lead me to believe also that the right eye (when under the influence of atropine) might show a still greater defect, which is now rendered "latent," or hidden, by an excessive development of the muscle of accommodation.

In all far-sighted eyes Nature tries from the date of birth to compensate for the congenital defect (an eye which is too flat) by a hypertrophy or *enlargement of the ciliary muscle* (see Fig. 2); hence, when this muscle is temporarily paralyzed by atropine, the true refractive condition of the eye is no longer masked. Far-sighted patients, therefore, lose their clearness of vision more or less at once when atropine is used. The normal or the "myopic" eye, on the contrary, is but little affected (as regards the outline of objects seen at twenty or more feet from the eye) by the use of atropine, although excessive light may annoy the eye in any case.

Let us now suppose that during the examination of a patient we first have examined each eye separately, carefully corrected all existing error found, and succeeded in getting $\frac{20}{xx}$, or normal vision, for each eye separately; that we have then tried both eyes together with the glasses best adapted for each, and found the patient able to read the normal type for distance without fatigue or conscious effort; and, finally, that we have made a careful record of each point noted during our observations. Are we now prepared to order glasses for the patient? Have we noted all that is important to note? To both of these inquiries I would say to the beginner, emphatically, "No." Several steps still remain to be taken, even before the use of atropine (which it is generally best to employ before a final decision is arrived at).

This brings us to the *tests for muscular insufficiency*. Until within a comparatively few years the necessity of carefully measuring the power of adduction and of abduction of the eyes, and of determining the presence or absence of muscular insufficiency in "nervous" subjects, seems to have been practically disregarded even by oculists. Even

to-day this defect (which probably is, as a rule, congenital) seems to be omitted from prominent mention among the enumerated list of ætiological factors of nervous symptoms by almost all authors of note. In some cases I have known it to be overlooked even by ophthalmologists of world-wide reputation, simply on account of a careless and hasty examination for the defect. It is an extremely common defect of the eye; and may prove a very serious one to the patient. It is an important factor in many subjects afflicted with headache; it often exists to a high degree in epileptics; it is frequently found among children who suffer from chorea; it may unfit a patient for sewing, reading, attending places of amusement, or using the eyes in any way for any length of time. I have known it to cause vomiting and so-called periodical "bilious attacks" by exciting a reflex irritability of the central nervous system. One patient of mine (a close student) was completely cured of chronic dyspepsia by the use of prisms which corrected an insufficiency of 6° of the external recti muscles; he now uses his eyes without fatigue, and all bodily ailments have disappeared without the use of drugs.

In order to properly determine the condition of the ocular muscles, several tests have to be made. I do not personally regard *any of these alone as sufficient for diagnostic purposes*. The tests which I advise you to invariably employ are as follows:

1. Direct the patient (as you see me do with a member of the class) to look fixedly with both eyes at some small object (say the point of a pencil), *and to follow it as I move it* before the face of the patient at a distance of about ten inches. I watch both eyes carefully at the same time and note if a *tremulous movement* in either eye is present in any position of the eye as it moves about, and if the two eyes act in perfect unison with each other.

2. While the patient is instructed to *fixedly gaze* at the same object, I next *shield one eye* with a card or sheet of paper so as to exclude the object from view, while I observe at the same time any deflection or trembling of the covered eye. If deflection or trembling occurs, it indicates a weak muscle.

3. I next place upon the patient a spectacle-frame previously arranged with a disc of ordinary glass tinted red to cover one eye, and a prism of 5°, with its base directed vertically downward, before the other eye. I then direct the patient's vision upon a candle-flame at a distance of twenty feet. The prism causes *two candles to appear* (one being colored red by the glass of that hue), both of which to the normal eye should be seen *in a vertical line*. If the red image is seen to the side of a vertical line dropped through the white image corresponding to the eye with the red glass, the external recti are insufficient; if the red image is seen on the opposed side of the vertical line, the internal recti muscles are weak.

4. Any deviation of the candle which exists can be remedied easily by placing a prism with its *base outward* before one eye for external insufficiency, and with its *base inward* for internal insufficiency. The strongest correcting prism that can be worn without an over-correction marks the degree of the "manifest" insufficiency only; hence we will note variations from time to time. I usually note both the weakest and the strongest prism which corrects the candle-deflection.

5. I next test and measure the *power of adduction and abduction* (convergence and divergence) of the eyes by means of prisms. To do this I set a lighted candle twenty feet from the patient on a level with his vision when seated. I then hold before one eye a prism, *with its base directed outward*, of sufficient angle to cause two images of the candle

to appear when both eyes look at the object. I then instruct the patient to make an endeavor *to draw the images together* and to fuse the two into one image. This is the *test for adduction* or *convergence*. The normal eye should overcome a prism of at least 23° to 25°. It may overcome 60° in some instances. In the same way a prism with its base directed inward is used to test the *power of abduction* or *divergence*. The external recti muscles should not fail to overcome a prism of at least 8°. By combining prisms of varying angles, one of the requisite angle can be easily obtained with but a few prisms in your trial-case. The power of *abduction* and *adduction* should always be recorded when accurately determined. One fact should be stated, however, in this connection—viz., that several sittings are usually required before the patient learns to use his eye-muscles to the best advantage; hence the records of daily tests should be kept for purposes of comparison for a short time (when practicable to do so).

6. The power of convergence and divergence of the eyes can be *estimated for near objects* by means of a stereoscope modified by Professor Henry D. Noyes, into which prisms may be dropped at will. I have used it of late with some satisfaction, but I find that the accommodation seems to modify the power of ocular muscles (as determined by the previous test at twenty feet distance). Prisms vary according to the glass used in their construction.

7. Following an example previously set by a late author, I record the results of the test (described as the third one) under the contraction for vertical diplopia—viz., v. d.

8. It is well to exercise the muscles of the eye with prisms before the results of the vertical diplopia test are finally recorded. I have found that, after a flexibility of the eye muscles has been obtained by the aid of prisms, an insufficiency of the internal or external rectus muscle will

sometimes manifest itself where it was not apparent at first. That this is not simply the result of fatigue seems proved by the fact that the insufficiency remains more or less apparent during subsequent examinations.

Thus far, then, in the examination, our record-page in blank would stand as follows:

Name..... Residence..... Date.....

O. D. V. = $\frac{20}{\quad}$ ..... corrected by .... *glass.*

O. S. V. = $\frac{20}{\quad}$ ..... " " .... "

Binocular V. = $\frac{20}{\quad}$ ..... " " .... "

V. D. .. insufficiency... " " .... *prism.*

Adduction, 20 feet, prism...$^{\Delta}$; 10 inches, prism...$^{\Delta}$.

Abduction, 20 feet, prism...$^{\Delta}$; 10 inches, prism...$^{\Delta}$.

Reading power at ..... inches, corrected by ..... glasses.

Astigmatism .... corrected by .....

Visual field.....

All the data indicated for record in this table, excepting the estimation of the degree of astigmatism and the outline of the visual field, have been referred to, and the tests for each have been given with some detail.

The *estimation and correction of astigmatism* is a difficult matter for a novice, and sometimes for an expert. It will be better understood by reference to and close study of the standard text-books on ophthalmology. Moreover, the ophthalmoscope is often required to properly estimate the degree and kind of astigmatism which exists. I would say, in passing, that a *high degree of astigmatism should never be disregarded* or left uncorrected, especially if present in connection with abnormal nervous phenomena. It is a very common cause of headache and asthenopic symptoms.

In *estimating the visual field*, an instrument specially designed for that purpose (the *perimeter*) greatly simplifies the step, and gives us at the same time an accurate repre-

sentation of its outline for subsequent reference. A drawing can be roughly made, however, of the visual field of any patient, by means of a blackboard and a piece of chalk, through a simple method described in most of the text-books. In some nervous cases it is very desirable that a register of the visual field be taken from time to time and preserved for reference.

Now, when we have carefully examined our patient respecting all the data indicated in the preceding table, are we safe in passing an opinion respecting the condition of the eyes? I would again say "No."

We have now reached a point where we should *administer atropine* to the patient. I usually employ a solution of gr. iv of sulphate of atropine to an ounce of distilled water. This can be kept constantly in your office in a phial with a rubber-top dropper substituted in place of a cork. A drop or two in each eye will suffice in most subjects to dilate the pupil widely and to paralyze the power of accommodation of vision for near objects in about three hours. In occasional instances it becomes necessary to keep the patient under its influence for several days, but this is not the rule.

It is well to caution the patient, after using this drug, that he may possibly suffer from the sunlight, and that colored glasses will relieve him of this annoyance. It is also best to tell him that his vision may become very blurred for distant objects in case he is far-sighted; and that, in any case, he will be *unable to read or to write by the aid of vision without glasses* for several days. I have known hyperopic patients to become greatly alarmed at the rapid loss of vision which has followed the use of atropine; all of which could easily have been avoided had they been prepared for it by timely words of explanation. It is always well to explain to far-sighted subjects the difference

between "manifest" and "latent" hyperopia, and to make them intelligent as regards the effect of atropine upon the "focusing" muscle before you administer it. If they are forced by their business to use their eyes for near-work while under the influence of atropine, a pair of cheap glasses may be given them for temporary use while under its influence.

I can not impress too strongly upon you the necessity of using atropine upon a patient (if young) for diagnostic purposes when an error of refraction or of accommodation is suspected. Personally, I *do not regard an examination as complete without it.* It solves the question of the presence of "latent" hyperopia—a very common defect and a very serious one (from the standpoint of the neurologist) if allowed to go unrecognized. It reveals the existence of a previous ciliary spasm. It often arrests headache as if by a magic touch, and solves the nervous origin of many other similar symptoms.

Patients who boast of their acuteness of vision, and who apparently justify their statement by reading test-type at a distance without the aid of glasses, are often astonished and sometimes alarmed at the immediate loss of this power which is brought about by the use of atropine. This surprise is heightened when (by the use of proper lenses) their power of vision for distance is immediately restored, and they become conscious for the first time of the muscular effort which they have been compelled in the past to exert in order to see without them. I shall never forget, personally, the sensation which I experienced of "seeing without effort" when a latent hyperopia was discovered in my own eye, and corrected by glasses.

These experiences are well-known facts among oculists, but to the profession at large they often occasion as much of a surprise as to the patient.

I could point to case after case in my own experience where the cause of neuralgic attacks, excruciating headache, vomiting, extreme nervousness, and many other symptoms (not apparently connected with eye-defect), would have remained unrecognized if atropine had not been employed. There is a rule given by most oculists—viz., to give to a hyperopic patient the *strongest convex glass* * with which he can comfortably read the normal test-type (xx) at a distance of twenty feet. It is impossible in many cases to decide this fact without atropine or an ophthalmoscope. The former method is the best one, because the accommodation of the oculist, as well as that of the patient, has to be excluded in the latter, and it has the advantage that it can be employed by the general practitioner as well as by the specialist.

Now, after the patient returns to you with widely dilated pupils, you should *carefully repeat each step of the previous examination.* You should record the results of these tests and then compare them with those obtained before atropine was employed. If the eye is a normal one, the vision will be $\frac{20}{xx}$ after atropine has been used, as it was on the first examination; but, when an error of refraction or accommodation exists, changes of a greater or less degree may be noted. You may find, moreover, that the power of adduction and of abduction of the eye will be modified in some patients by the action of the drug upon the accommodation of vision, and that a different degree of muscular insufficiency may be detected. You can now decide

* The advisability of a full-correction by glasses of existing hyperopia can only be decided after the condition of the patient, his age, his susceptibility to reflex irritation from eye-strain, etc., have been carefully considered. It is not usually advisable to force a young subject to wear a glass which fully corrects the *latent* hyperopia.

intelligently as to the glass which is best adapted to restore vision for distant and near objects in each eye of the patient, and you are prepared to advise the patient respecting the use of the glasses selected. You can decide also respecting the question of the utility of prisms or of tenotomy if the patient has marked insufficiency of the muscles. You can judge more accurately respecting the proper angle of the prism required in case their use is indicated. I would caution you, however, against deciding this latter point *before the error of refraction* (if such exists) *is corrected*, and not until the "vertical diplopia test" has been employed, after such lenses as are required to correct it have been placed before the patient's eyes. I have seen patients who gave evidence of marked insufficiency (5° to 8°), when the refractive error was uncorrected, exhibit no such defect when glasses which corrected that error were worn. Prisms in such a case would inflict injury upon the patient rather than afford relief.

In closing this lecture, I would remark that views which I have advanced respecting the dependence of abnormal nervous phenomena upon eye-defect are not new. They are in antagonism, however, to those of some authors, and have been more or less actively combated of late, especially in regard to eye-defect as a cause of chorea and epilepsy. I do not think the relationship between "eye-strain" and attacks of headache or neuralgia can be denied, although it is only hinted at by Anstie and is omitted by most authors who have written on the causes and cure of these distressing maladies. Some of our best neurologists, as well as most oculists, are now investigating with renewed interest not only the ametropic conditions of the eye, but also the eye with "insufficient" muscles. Facts are being daily substantiated beyond dispute which met with ridicule some years since. Every day, in my own experience, I am

strongly impressed with the curative effects of glasses in various forms of functional nervous disturbances. In my opinion, the neurologist of to-day who fails to familiarize himself thoroughly with the examination of the eye omits an evident line of duty both to himself and his patients. No neurologist can send all of his cases to an oculist for an opinion, and, even if he could do so, he should at least be able to verify the opinion thus gained respecting the *refractive errors* found and the *state of the eye-muscles.** He requires a case of lenses and prisms in his office as much as an electrical outfit, and he should know how to use both—the one as an aid in diagnosis, and the other as a means of cure. Personally, I have come to regard the examination of any patient sent to me as incomplete until I have tested the state of refraction and accommodation, and examined with care the condition of the ocular muscles. This view has not been hastily formed, and my daily experiences confirm me in it. I believe the time will come when the tests employed in eye-examinations will rank in importance in neurology with the knee-jerk test, which for generations, as Gowers remarks, simply "amused school-boys."

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